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MMI 601 - Transducer Theory
Final Project
Loudspeaker Design and Build

Loudspeaker Design

Introduction

For my final project, I've chosen to build a bookshelf loudspeaker. I purchased the Copperhead Desktop Speaker Pair kit from Parts Express and will build one of the units. I will also use WinISD to simulate the speaker's behavior and compare that to the spec sheet and the actual performance of the build. In the future, I will build a Matlab "Loudspeaker Designer" application using App Designer, and I'll further test both the app and the design of the speaker and see how it matches up with the specifications and actual performance.

Intended Application

Desktop or bookshelf speakers are most commonly used for casual listening and everyday computer use. However, it can also be useful to have a single (or pair of) consumer speaker(s) to use when mixing audio. So, I plan to use this speaker as a mono monitor (similar to a "mix cube") to expand the functionality of my current stereo setup. Eventually, I may choose to build another speaker to complete the pair, and a sub to complete a full 2.1 setup.

Design Choices

The design choices are constrained by the specifications of the speaker kit. The driver is a Dayton Audio PS95-8 (3.5", 8 ohm, point-source) full range driver. The cabinet is 8" x 5" x 6.5", and I plan to follow the building manual exactly. However, one choice that could be made involves the notch filter. The notch filter compensates for the boost from about 1kHz to 3kHz in the speaker's natural response. A switch could be implemented to toggle a bypass of the notch filter for a slightly different frequency response, but the main obstacle for me is cutting out a square for the switch, so I will have the notch filter hard-wired into the signal chain.

Dayton Audio PS95-8

Parameter	**Value**
Impedance	8 Ohms
Re (DC Resistance)	7.1 Ohms
Le (Inductance of Voice Coil)	0.63 mH @ 1 kHZ
Fs (Resonant Frequency)	119.8 Hz

Parameter	Value
Impedance	8 Ohms
Re (DC Resistance)	7.1 Ohms
QMS (Q Factor, Mechanical)	7.33
QES (Quality Factor, Electrical)	0.80
QTS (Quality Factor, Total)	0.72
MMS (Moving Mass of Diaphragm incl Air)	2.2 grams
CMS (Suspension Compliance, Mechanical)	0.79 mm/N
Sd (Area of Diaphragm)	28.3 cm^2
Vd (Volume of Diaphragm)	7.08 cm^3
BL	3.83 Tm
VAS (Equivalent Compliance Volume)	0.94 liters
Xmax (Maximum Driver Excursion)	2.5 mm
VC Diameter (Voice Coil Diameter)	20 mm
SPL	85.66 dB @ 2.83 V / 1 m
RMS Power Handling	10 watts
Frequency Range	110 - 20,000 Hz

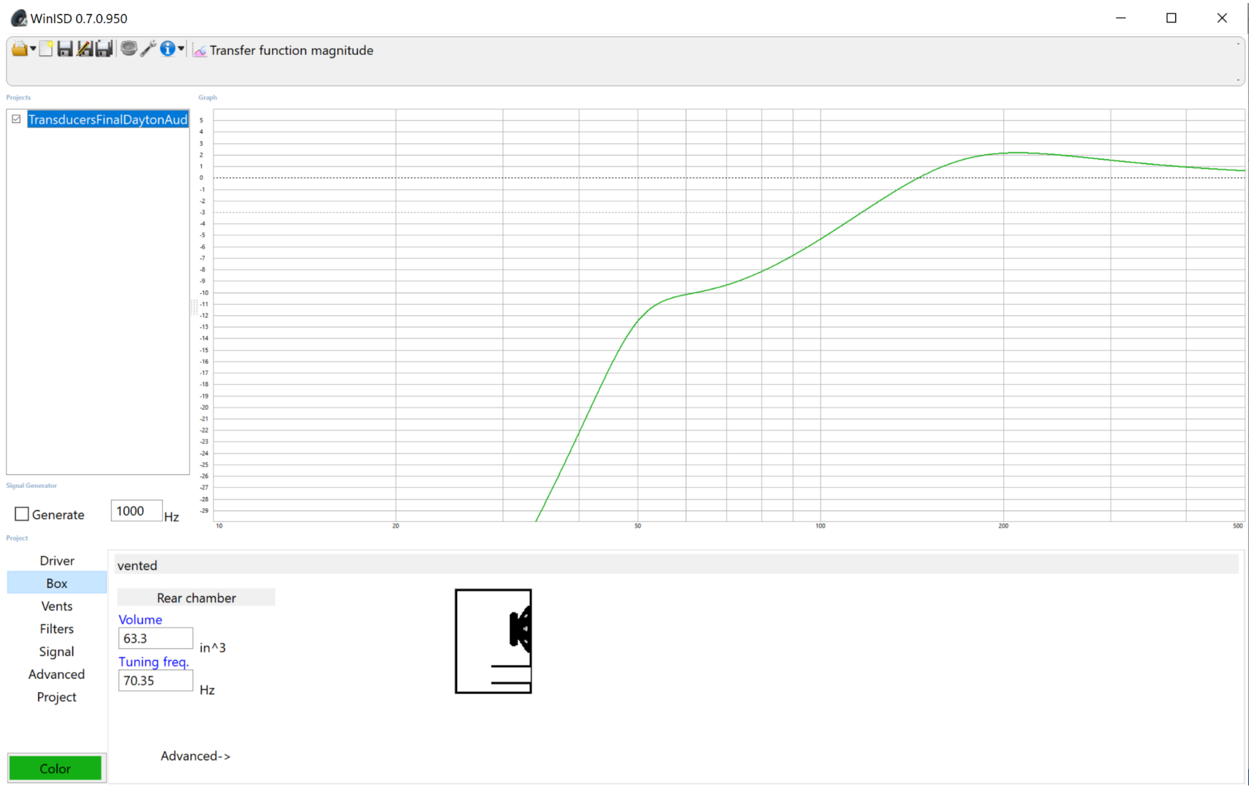
Prediction

The “prediction” was completed using WinISD, and further testing was done in Weeks 108 to determine the SPL at 1 meter of different frequencies. It is important to note that because the build came as a kit, this prediction is essentially confirmation (or not) of the speaker’s actual performance, as opposed to guidance on what size the enclosure and port should be. The table below details the SPL measurements taken approximately 1 meter from the driver.

Frequency (Hz)	SPL @ 1 meter (dBA)
20 Hz	N/A (outside of driver range)

100 Hz	40 dB
1,000 Hz	71 dB
10, 000 Hz	58 dB

The image below shows the frequency response and tuning frequency of the driver in a ported enclosure with the same dimensions as the actual build.



The frequency response in the plot is consistent with testing of the actual speaker, which showed a noticeable lack of bass frequencies. Overall, when tested with a matching pair, the Copperhead Desktop Speaker Pair sounded quite similar to MacBook Pro laptop speakers.

Conclusion

This project is a strong demonstration of the versatility of speaker design software and good practice for designing and building speakers. In the future, I plan to finish building my Loudspeaker Designer matlab app, and to build an enclosure from scratch for a subwoofer.